6.—The Status of Yarra singularis and Geotria australis (Petromyzontidae)

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Extensive references to publications on the lampreys of the Southern Hemisphere may be found in Regan (1911) and Whitley (1932, 1940). In this paper, reference is made only to those authors whose opinions have radically affected the taxonomy of the group.

The name *Yarra singularis* was given by Count F. de Castelnau in 1872 to a single ammocoete from the Yarra River, Victoria, Australia. He described it as follows: "The body is eel-shaped, naked, cylindrical and elongate, being 23 times as long as high. It is entirely divided into annular rings, which appearance seems to be due to the muscular flakes being very visible through the smooth skin. I can see no teeth, the upper lip is flat and considerably prolonged over the buccal aperture; it is truncated in front and this part seen upperly is rather bifurcated. The lateral line is well-marked in all the length of the body; there is only one dorsal fin, which begins at about two-thirds of the length of the body and is joined with the caudal and anal fins; the latter is considerably shorter than the dorsal. No eye visible. The skin of the throat is rather extensible; the prolongation of the upper lip over the lower is equal to the height of the body. The tail is pointed. The colour is of light green with the belly white; on the back extends a narrow longitudinal line; the head and throat are pink and the fins of the same colour." It was 11 cm long.

Castelnau's first impression was that he had an ammocoete of *Geotria australis* Gray but, because he had seen a specimen only 8 cm long which had more adult-like characteristics, he rejected the assumption on the ground that the more juvenile form could not have been larger than the more mature form. This reasoning is invalidated by the fact that lampreys suffer a reduction of size during metamorphosis.

Gray (1851) erected the genus *Velasia* for a Chilean lamprey in the British Museum, contrasting this with the Australian *Geotria*, but Günther (1870) united the two genera, reducing *Velasia* to *Geotria chilensis* (Gray). Günther also erected a new species, *G. allporti*, on the basis of a single, extremely decomposed specimen from Tasmania. The outer cusps of the supraoral lamina were described as being "finely serrated on the inner margin." I have examined the type specimen in the British Museum and find that this is due to the loss of the superficial horny cap of the lamina. The condition can be duplicated by prising off the horny layer of the lamina of a typical *Geotria australis*.

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Ogilby (1896) reverted to the older distinction between *Geotria* and *Velasia*, based on characters set out in Table I.

TABLE I

Characters distinguishing Velasia from Geotria (according to Ogilby, 1896)

Geotria	*Velasia*
Body rather short and stout	elongate and slender
Head large	small
Suctorial disc very large, broader than long, extending backwards more than mid-way to the eye	very small, longer than broad, extending backwards mid-way to the eye
Outer lip rudimentary	present, continuous behind
Surface of disc smooth	plicated
Dental plates grooved	smooth
Discal teeth widely separated	approximated
Ventribasal plate of tongue bicuspid	usually tricuspid
Origin of first dorsal fin on last third of body	middle third of body
No series of pores on head or trunk	head and trunk with conspicuous series of open pores, forming a well-marked lateral line

Within the genera so separated, Ogilby erected the species, *Velasia stenostomus* Ogilby, to which he relegated part of *Geotria chilensis* of Günther, *Yarra singularis* Castelnau, and *Neomordacia howittii* Castelnau, this last-named being another genus erected on the basis of a single juvenile specimen. With respect to the latter two, Ogilby wrote: "From the size of the specimens, the insufficiency of the descriptions and the destruction or loss of the type, it will always be impossible to say whether I am justified in my conclusions or, indeed, to what species his (Castelnau's) immature and ammocoetal forms should be united. If however, the types are extant and on examination show that my identification is correct in one or other instance, Castelnau's name must necessarily have priority over mine."

Dendy and Olliver (1901), having access to a large sample of New Zealand lampreys caught at the same time in the same locality, recognised a range of forms intermediate between *Geotria australis* Gray and *Velasia stenostomus* Ogilby. They reached the conclusion that the latter were immature stages of the former, this being supported by dissection, which revealed that the pouched forms were sexually mature, whereas the unpouched forms were all immature. They therefore proposed "to call the adult form, *Geotria australis*, and to use the term *"Velasia"* to distinguish the larva . . . . it appears that, whereas the northern lampreys of the genus

Petromyzon undergo only one metamorphosis—namely from the *Ammocoetes* to the adult—the southern form *(Geotria)* undergoes two well-marked changes, from the *Ammocoetes* to the *Velasia* and then from the *Velasia* to the adult, which latter represents a further stage in development never reached by northern forms."

Meanwhile Plate (1897) had erected a new genus and species, *Macrophthalmia chilensis* Plate, for a small, slender, striped lamprey from Chile, which he later (1902) recognised as a young stage of *Geotria chilensis* (Gray). This, as has been mentioned, was regarded by Ogilby (1896) as synonymous with *Velasia stenostomus* Ogilby which, in turn, was shown by Dendy and Olliver (1901) to be an immature form of *Geotria australis* Gray. In addition to this species, Plate (1897) recognised among the lampreys of the Southern Hemisphere, *Geotria australis* Gray, *G. stenostomus* (Ogilby), *Exomegas macrostomus* (Burmeister), and three species of *Mordacia*.

Regan (1911), recognised *Geotria australis* Gray, *G. chilensis* (Gray) and *G. stenostoma* (Ogilby), and added the new species, *G saccifera* Regan, based on a single, pouched specimen from New Zealand. *Exomegas macrostomus* (Burmeister) was placed in the genus *Geotria* as *G. macrostoma* (Burmeister).

Maskell (1929), continuing the study begun by Dendy and Olliver, clarified the situation considerably. *G. stenostoma* (Ogilby) was shown to be indistinguishable from *G. chilensis* (Gray), each therefore being equivalent to the 'velasia' stage of *G. australis* Gray. *G. macrostoma* (Burmeister) had been shown by Lahille (1915) to be indistinguishable from *G. australis* Gray, and Maskell pointed out that since the diagnosis of *G. saccifera* Regan rested on characters which varied continuously between the 'velasia' and the adult of *G. australis* Gray, it could not be accepted as a valid species. I have examined the type specimen of *G. saccifera* Regan in the British Museum and can confirm Maskell's deduction.

In the light of Maskell's revision, there thus appears to be only one species of *Geotria*—*G. australis* Gray—in the life-history of which there are four stages: (i) the ammocoete, (ii) the 'macrophthalmia', (iii) the 'velasia', and (iv) the sexually mature adult. This might appear to be a rather tenuous argument were it not for the fact that Maskell, in New Zealand, collected a complete series of such stages and intermediate forms between them. In the Warren River at Pemberton, Western Australia, I have been able to collect a similar series.

Although it would seem that the matter has been settled since 1929, Whitley (1932, 1940) has reverted to the attitude of Ogilby (1896) in placing the 'velasia' apart as a separate genus on the grounds that "It is not definitely proven that this nominal species is merely a form of *Geotria*, but Dr. Maskell's researches in New Zealand indicate that such may perhaps be the case." Whitley does not refer to the 'velasia' by Ogilby's name, but as *Yarra singularis* Castelnau, since "Most authors are agreed that *Yarra singularis* and *Neomordacia howittii* are names given by Castelnau to young *Velasia stenostomus* Ogilby, but the first name, being the oldest, must be employed for this species." Reference has already been made to Ogilby's reservations on this point and his own doubts are also indicated by a question mark against *Yarra singularis* and *Neomordacia howittii* in his list of synonyms for *Velasia stenostomus*. Subsequent authors have followed Ogilby, but without noting his reservations and their unanimity has no significance.

All that can be said on the evidence offered by Castelnau is that the position of the dorsal fin makes it unlikely that his ammocoete was that of *Mordacia*. There was not in Ogilby's time nor is there at present any way of distinguishing between the ammocoetes of *Geotria* and *Velasia* (which is understandable if the latter has no separate existence), so there is quite as much justification for placing *Yarra* with *Geotria*, in which case the name would have no priority. The existence of the genus *Yarra* thus depends upon establishing a generic difference between *Geotria* and *Velasia*. The characters upon which Whitley attempts to do this are set out in Table II.

TABLE II

Characters distinguishing Yarra from Geotria (according to Whitley, 1932)

	Geotria	*Yarra*
1.	Mouth surrounded by expansive fringes	fringes moderately developed
2.	Labial teeth well-separated	close together
3.	A large gular pouch developed by either sex	no gular sac
4.	Length up to 20 inches	length up to 24 inches
	Additional characters, Whitley (1940)	
5.	Supraoral lamina with broad lateral cusps	——
6.	Anterior tooth tricuspid	——
7.	Back uniform blackish or dark brown	back slate-colour or bluish, sides bronze, silvery on sides of head, fins yellowish or reddish with slaty margins
8.	Without green stripes	a green stripe along each side of back.

None of these distinctions is inconsistent with the belief that *'Yarra'* is an immature stage of *Geotria*, as is demonstrated in the considerations listed below, the numbered paragraphs referring to the numbered characters in the Table.

(1, 2).—It is significant that in spite of an alleged generic difference, the pattern of the teeth on the buccal funnel is the same in *'Yarra'* and *Geotria*. The wider spacing of the teeth in *Geotria* is to be expected if the buccal funnel becomes enlarged towards the end of the life-history, continuing a trend which is first manifested in the transformation from 'macrophthalmia' to 'velasia'. Many specimens can be found (there are a number in the Western Australian Museum) in which the buccal funnel is intermediate between that of a typical *'Yarra'* and that of a pouched lamprey.

(3).—A gular pouch of the size depicted in most illustrations of *Geotria* is a rarity and, as suggested by Maskell (1929), is probably an artifact of preservation. In many cases it is augmented by putrefaction. The type specimen of *G. australis* Gray was picked up on an estuarine beach where, to judge from the state

of the specimen, it had lain for some time. The type specimen of *G. saccifera* Günther, which has a large pouch, is so far decomposed as to be almost devoid of skin. One 'macrophthalmia' in my possession, which was not preserved until some five hours after its death, developed a marked gular swelling.

Pouches of 1-2 cm depth are common and present in individuals which, on the basis of length and shape of head, would be classified as *'Yarra'*. This is consistent with the view that the pouch becomes hypertrophied at the end of the life-history. Maskell (1929) found a large pouch only in males.

(4).—Pouched forms are generally shorter than unpouched forms, as is shown in Table III.

TABLE III

Comparison of average total length of pouched and unpouched lampreys of the genus Geotria and 'Velasia' (Numbers in brackets indicate size of sample)

Source	Pouched	Unpouched
W. Australia, fresh specimens (R.S.)	60 cm (8)	66 cm (30)
New Zealand, preserved? (Maskell, 1929)	48 cm (6)	55 cm (9)
E. Australia, preserved (R.S.)	45 cm (11)	51 cm (11)
E. Australia, preserved (Brit. Mus.)	41 cm (4)	51 cm (4)
Argentine, preserved (Lahille, 1915)	36 cm (1)	53 cm (19)

Any reference to total length is complicated by the shrinkage of lampreys preserved in spirit or formalin. Thus, although the data of Table III suggest a difference in size between pouched lampreys from eastern and Western Australia, a definite opinion cannot be given until measurements have been made on fresh specimens from eastern rivers. It is, however, important to note that fresh pouched specimens from Western Australia fall outside the range of size given in Whitley's description.

Cotronei (1926), Hubbs (1925) and Zanandrea (1940) have shown that lampreys of the Northern Hemisphere decrease in length prior to spawning, this shortening being mainly in the caudal region and leading to a reduction in the distance between the caudal fins. Maskell (1929) has given convincing arguments for the same phenomenon in *Geotria australis*, which would dispose of Ogilby's (1896) distinction between *Geotria* and *'Velasia'* on the relative position of the first dorsal fin (see Table I), and Lahille's distinction between *G. australis* and *'G. chilensis'*, based on similar criteria.

(5).—The lateral cusps of the supraoral lamina are wider in pouched specimens and separated from the basal plate by a distinct groove. However, individuals with small pouches and only slightly expanded buccal funnels have lateral cusps of intermediate size, which are separated from the basal plate by a slight greove. It is reasonable to assume that the expansion of the lateral cusps is the result of hypertrophy of the funnel.

(6).—Whitley's statement that the anterior lingual tooth of *Geotria* is tricuspid is evidently a *lapsus*, since his figure shows two cusps. Ogilby (1896) stated that the tooth was bicuspid in *Geotria* and 'usually tricuspid' in *'Velasia'* (Table I). Lahille (1915) figured a series of growth stages in *'G. chilensis'*, depicting the change from tricuspid to a more or less bicuspid condition. Maskell (1929) showed that the condition was variable in the unpouched forms and apparently dependent upon the number of times the outer horny cap had moulted. In the 'macrophthalmia' the tooth is tricuspid and the middle cusp is the tallest of the three. In unpouched forms the middle cusp, if present, is smaller than the lateral cusps. In pouched forms it is usually absent, but may be present as a small hillock. Thus it appears that, as the lamprey grows older, the middle cusp diminishes in relative size.

(7, 8).—The distinctive coloration of unpouched specimens was described by Ogilby (1896) and is quoted in Whitley's diagnosis. The coloration is similar to that noted by Plate (1897) and Maskell (1929) for the 'macrophthalmia'. Here the body has a silvery sheen and a dark mid-dorsal line extends from the pineal region to the posterior end of the body. On either side of the dark line are two iridescent blue-green bands which extend to the tip of the head, being interrupted over the eyes. The distal edges of the dorsal fin are bordered with dark pigment and the fins themselves are tinged pink by the contained blood. Maskell (1929) and Lahille (1915) have recorded a silvery sheen and brilliant blue-green dorso-lateral stripes in unpouched lampreys entering rivers from the sea and both Maskell (1929) and Mann (1954) are of the opinion that this bright coloration becomes obscured by degenerative changes in the skin as the animals migrate upstream. Applegate (1950) records similar reduction in the intensity of the colour pattern of *Petromyzon marinus* near its spawning beds.

From my own observations at Pemberton, Western Australia, I can add that the great majority of individuals which, according to body form, would be classified as *'Yarra'*, have dull, blue to brownish-grey coloration, darker above than below. In occasional individuals, green dorso-lateral stripes are just discernible below the almost opaque epidermis. It is obvious that colour pattern is not a good character for distinguishing lampreys near their upstream spawning beds, and the lack of bright coloration in pouched specimens is consistent with their having been longer in the rivers than the unpouched forms.

Conclusion

It may be argued that these considerations do not *prove* that *'Yarra'* is the 'velasia' stage of *Geotria*. Whitley (1940) has intimated that it may be a neotenous form, which is to say that it is a species which becomes sexually mature while possessing the other characteristics of an immature stage of a related species—presumably *Geotria australis*. This hypothesis assumes, therefore, the existence of a 'velasia' stage in the life-history of *Geotria* but fails to offer any criteria, apart from sexual maturity, whereby *'Yarra'* may be distinguished from it. The argument therefore turns on the sexual maturity of *'Yarra'*, for which no evidence has been put forward in opposition to the findings of Dendy and Olliver (1901). It should be borne

in mind, in view of Maskell's (1929) finding that only male *Geotria* have large pouches, that '*Yarra*' would need more substantiation than the discovery of a pouchless mature female.

The occurrence of neotenous, 'non-parasitic' lampreys in the Northern Hemisphere is so widespread that it would not be surprising to find some such instance among the southern forms but, as yet, there is no evidence of them. There is therefore no reason to depart from the finding of Dendy and Olliver (1901) that *Velasia stenostomus* Ogilby 1896 is synonymous with *Geotria australis* Gray 1851. The ammocoete which was described as *Yarra singularis* Castelnau, (1872) is now missing and the description is insufficient to allow its separation from ammocoetes of *Geotria australis* Gray (1851). I am of the opinion that *Yarra singularis* Castelnau must be treated as a synonym of *Geotria australis* Gray.

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